APPENDIX A

EXAMPLE DESIGN OF A POND

USING A SHORT CUT ROUTING PROCEDURE

Given: John Doe Farm, Structure #2 - The drainage area of the site is 237 acres, all uncontrolled. The time of concentration is 0.8 hours.

The state-storage relationship of the reservoir with the permanent pool set at elevation 50.7 is given in the following table:

Stage (Feet)	Storage (Ac.Ft.)
1.9	3.6
3.8	8.2
5.3	13.5
6.4	18.2
6.9	20.5

The structure is an "a" hazard pond having a storage height product less than 3000. The principal spillway hydrograph is based on a 25 year frequency design. The 24-hour duration point rainfall depth is 4.9 inches.

The runoff curve number for antecedent moisture condition II is 72.0.

A single stage inlet riser will be used and the principal spillway will discharge into the atmosphere so the tailwater elevation at the conduit outlet may be taken as 0.6 times the diameter of the conduit above the outlet invert, elevation 39.5.

Find: Design the pond. Determine the most economical structure proportions including size of principal spillway, elevation of the emergency spillway crest, elevation of the top of fill and the emergency spillway size.

1. Compute the peak runoff rate from the watershed (Qi).

2. Develop the stage storage curve for the site.

3. Set up a table to help in evaluating the most economical structure proportions. See Figure A-1

4. Select range in conduit sizes desired. (Line 1.)

5. Select a trial stage to the crest of the emergency spillway. (Line 2.)

6. Compute the pipe length required. (Line 3.)

7. Compute the tailwater elevation. (Line 4.)

8. Compute the head from the tailwater elevation to the crest of the emergency spillway. (Line 5.)

9. Determine the conduit full-flow capacity. See Chapter 3, North Dakota Supplement to the Engineering Field Manual.

10. Compute B, the ratio of Q_o/Q_i. (Line 7.)

11. Determine the value of K (coefficient in a $V_s = K\ V_r$) from Figure A-2. (Line 8.)

12. Compute the volume of temporary storage required $V_s = K\ V_r$. (Line 9.)

13. Read the available storage (V_s) from the stage-storage curve. (Line 10.)

14. From the stage vs. storage curve determine the required stage to provide for this storage. This is the minimum elevation of the emergency spillway crest. (Line 11.)

15. The minimum stage over the inlet to insure that the pipe will prime is checked. (Line 12.) The minimum stage depends on whether the design involves hood or riser inlets. See Chapter 3, North Dakota Supplement to the Engineering Field Manual.

    Depending upon the relative cost of the spillway as a part of the total structure cost, the 21" size looks appropriate. Note the 36" pipe in the example is not feasible because the priming stage is nearly equal to the required stage. For safe design, a minimum one foot stage should be maintained between the required priming elevation and the emergency spillway crest elevation.

16. From Table 1-7, Page 1-30, the emergency spillway capacity should be Q_{25} = 153 cfs (less than 50 ac. ft).

17. From Chapter 3, North Dakota Supplement to the Engineering Field Manual, an emergency spillway design can be chosen to fit the site. From the above reference, use an emergency spillway with H_p = 1.5 feet and a bottom width of 41 feet. The inlet channel to the emergency spillway should be at a -2% or steeper grade and the outlet channel should be constructed to a grade steeper than 3% but flatter than 10%.

18. Summary of elevations.

    Permanent pool elevation (crest principal spillway) = 50.7.
    Emergency spillway crest elevation = 50.7 + 5.3 (Figure A-1) = 56.0
    Top of fill elevation = 56.0 + 1.5 + 1.0 (Freeboard) = 58.5.
    Use Elevation 59.0 1/
    Outlet invert elevation = 39.5.
    Tailwater elevation = 39.5 + .6(1.75) = 40.6.

1/ Minimum as per pond standard 378A, requires at least 3.0 foot depths for the emergency spillway.

FIGURE A-1

FLOOD ROUTING
By Short Cut Procedure

Project JOHN DOE Job No. STRUCTURE #2

D. A. = 237 Ac., Design frequency = 25 YR Runoff Curve No. = 72,

Rainfall = 4.9", Q = 2.12", Tc = 0.8 hr., Hyd. Fam. = 1.4,

q_p = 195 CSM/in., Q_i = 195 x $\frac{237}{640}$ x 2.12" = 153 cfs.,

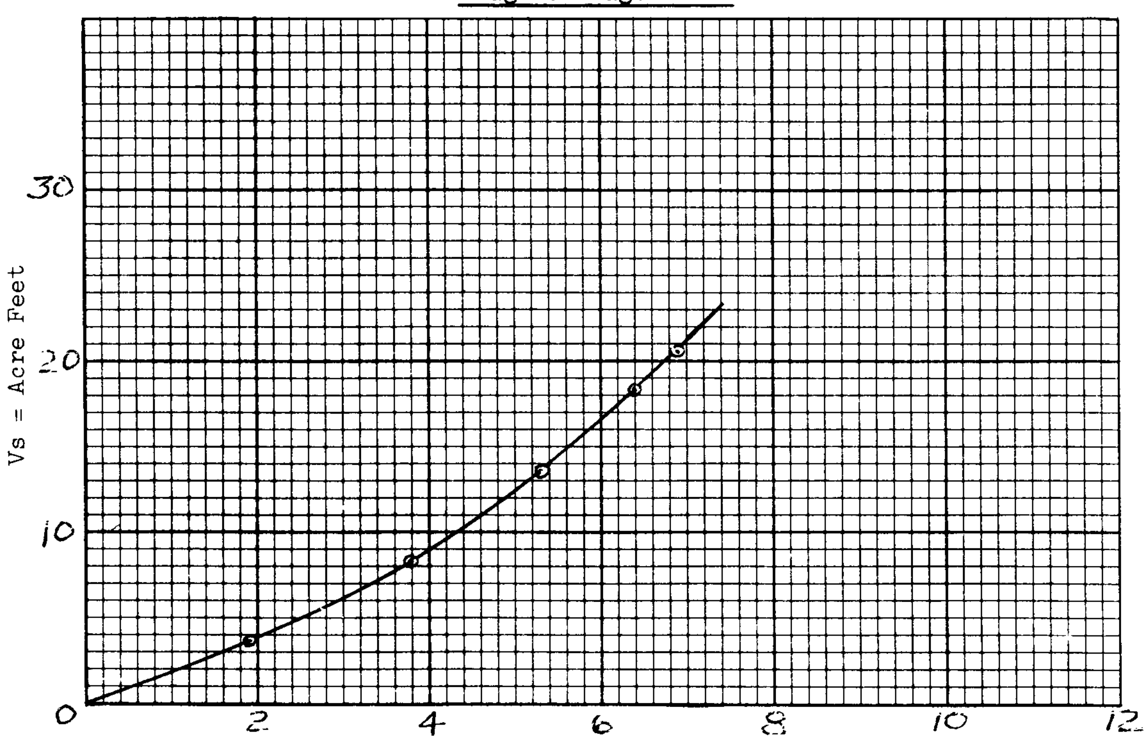
$V_r = \frac{2.12''}{12}$ x 237 = 41.9 ac. ft., Elev. of prin. splwy. crest = 50.7,

Sediment storage requirements: Below crest 7.9 Ac.Ft. Above crest —— Ac.Ft.

Invert outlet elevation = 39.5. Develop stage-storage curve - (see below).

Trial	1	2	3	4	Final
1. Select pipe diameter	18	24	30	36	21
2. Select stage	5.5	5.5	5.5	5.5	5.5
3. Compute pipe length	80	80	80	80	80
4. Tailwater Elev.	40.4	40.7	41.0	41.3	40.6
5. Compute Head	15.8	15.5	15.2	14.9	15.6
6. Qo	20.8	41.6	70	107	30
7. Compute B = Qo/Qi	0.14	0.27	0.46	0.70	0.20
8. K = Vs/Vr	0.40	0.27	0.19	0.11	0.32
9. Compute required Vs = KVr	16.8	11.3	8.0	4.6	13.4
10. Available Vs (see curve below)	14.5	14.5	14.5	14.5	14.5
11. Required stage (see curve below)	6.1	4.7	3.7	2.3	5.3
12. Min. priming stage	1.0	1.3	1.7	2.0	1.2

Stage-Storage Curve



USDA-SCS

SHORT-CUT PROCEDURE FOR

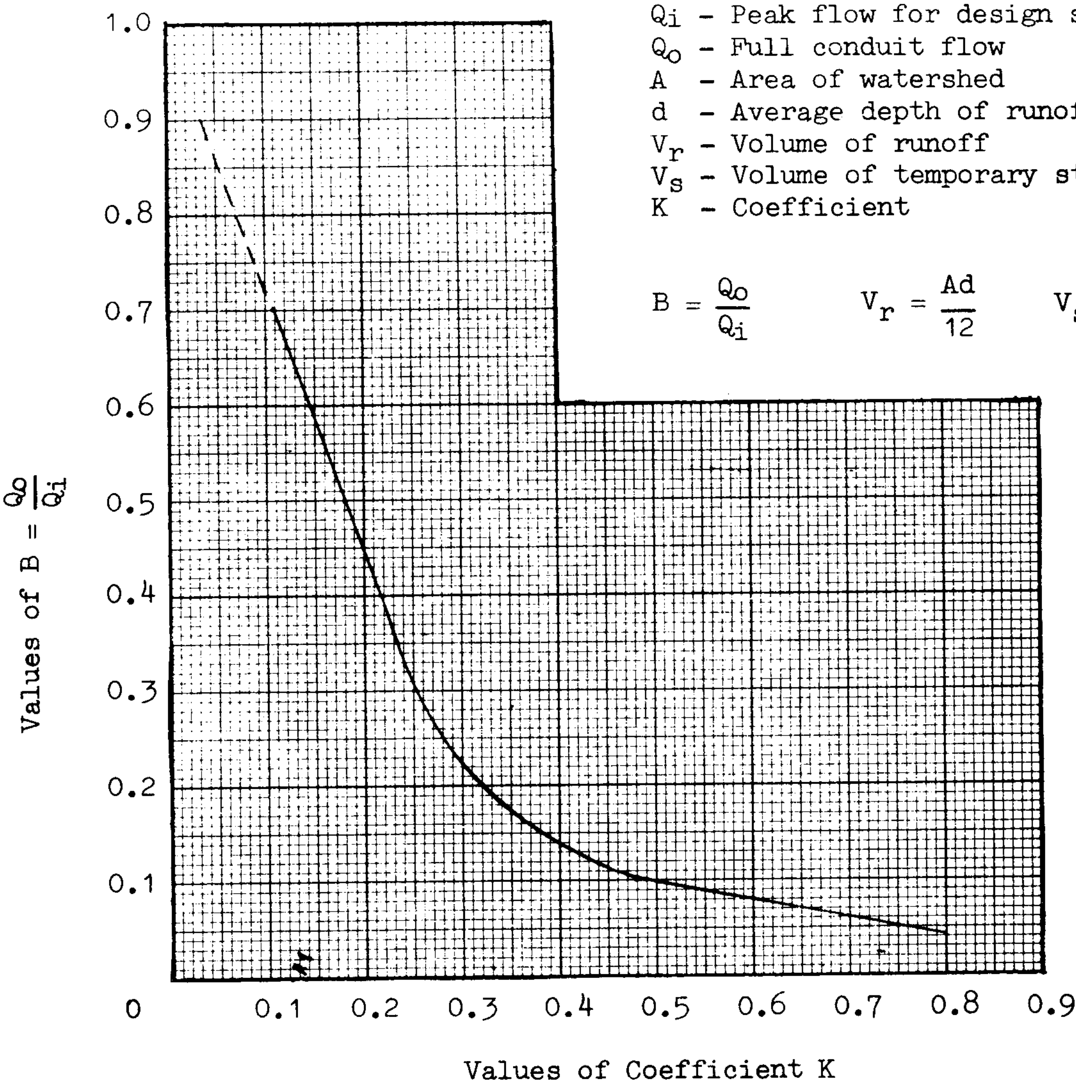
DESIGN OF STRUCTURES WITH TEMPORARY STORAGE

24 HOUR DURATION – TYPE I DISTRIBUTION STORMS

NOMENCLATURE

Q_i	– Peak flow for design storm	cfs
Q_o	– Full conduit flow	cfs
A	– Area of watershed	Acres
d	– Average depth of runoff	Inches
V_r	– Volume of runoff	Ac. Ft.
V_s	– Volume of temporary storage	Ac. Ft.
K	– Coefficient	

$B = \frac{Q_o}{Q_i}$ $\qquad V_r = \frac{Ad}{12}$ $\qquad V_s = K\,V_r$



The use of this method is limited to PL 46 structures and has been found to be appropriate when:

a. The drainage area is less than 250 acres.
b. Structures do not fall within the scope of hydrologic criteria established in T.R. 60
c. The principal spillway discharge is primarily pipe flow. When the principal spillway discharge is primarily weir flow, this procedure is not accurate.

FIGURE A-2